

# Notes

<b>Meeting title:</b>	International Scientific Panel Steering Group Meeting	
<b>Date:</b>	15 <sup>th</sup> November 2012	Time: 10:00-15:00
<b>Location:</b>	University of Southampton, Building 19, Room 3011	
<b>Present:</b>	Prof Andrew McNaughton (AMcN) (Chair) – HS2 Dr Gunnar Baumann (GB) – Deutsche Bahn Prof Anders Ekberg (AE) – Chalmers Dr Pierre–Etienne Gautier (PEG) – Inexia Prof António Gomez Correia (AGC) – Universidade do Minho, Portugal  Dr Simon Blainey (SPB) – University of Southampton Dr Jean–Francois Ferrellec (J–FF) – University of Nottingham Dr John Harkness (JH) – University of Southampton Dr Louis Le Pen (LLP) – University of Southampton Prof Glenn McDowell (GMcD) – University of Nottingham Prof William Powrie (WP) – University of Southampton Prof John Preston (JMP) – University of Southampton Dr Jeffrey Priest (JAP) – University of Southampton Dr Joel Smethurst (JAS)– University of Southampton Prof David Thompson (DJT) – University of Southampton Ms Carole Walker (Secretary) (CAW) – University of Southampton Dr Antonis Zervos (AZ) – University of Southampton	
<b>Apologies:</b>	Prof Clive Roberts – University of Birmingham (CR) Dr Paul Weston – University of Birmingham (PW)	

## Introduction

Summary reports for each work area, covering the aims and objectives as stated in the initial research proposal, key activities and outcomes to date, and proposed further work, were circulated to International Scientific Panel steering group members in advance of the meeting. At the meeting, presentations on each work area were made, followed by a question and answer session in which the progress to date and proposed future activities were discussed. This document records the comments made in discussion of the reports and presentations, and at the end summarises the broad conclusions reached by the ISP regarding progress to date, future direction and opportunities for developing international research collaborations.

Professor Buddhima Indraratna was not able to be present at the November meeting, but had previously visited the Group in May and been shown and invited to comment on the work to date at that time.

## Work Area 1: Railway Foundations / sub-base (Presentation by WP)

- *Acceleration and deceleration effects.* AE – The stresses resulting from applied lateral loads are usually thought to diminish rapidly with depth; it would be sensible to confirm their likely significance before embarking on a major investigation of their effects. AMcN – What happens if you have braking/acceleration effects combined with lateral loading effects on curves, how good is the evidence that the effects of those two horizontal loads dissipates very quickly in the initial loadings? WP – That is not a calculation we've done, and while there is anecdotal evidence that acceleration loads at least can be a problem (perhaps depending on ground conditions) there doesn't seem to be very much published information, especially on the effects of combined lateral and longitudinal forces. PEG –

Something that should be investigated more is the effect of lateral forces in narrow curves or with higher cant deficiencies because then you have a combination of vertical and lateral forces.

- GB – It will be important to consider the influence of track irregularities in increasing dynamic loads. WP – That would be a good aim for further work. It would also be good to start to link observed features like that to some of the work we've been doing in the lab and theoretically, perhaps by means of the field studies we've now started in collaboration with Network Rail.
- PEG – (i) Soil damping is an important characteristic and worthy of study; (ii) Unsaturated soils is a huge research area and may be beyond the scope of Track21; (iii) The interaction between ballast and subgrade needs to be considered. WP – all agreed.
- PEG – The number of cycles tested in the HCA seems quite low. WP – Because we have incremented the shear stress cycle in steps we have not hit one that is only just stable. Thus it has been clear after about a thousand cycles whether there will be a failure or not, and we have not had to go to millions of cycles to assess this with the stress combinations we've looked at.
- *Vegetation effects and earthworks stability.* AMcN – Are we heading towards a view that there is a vegetation level that is acceptable? JAS – yes, mainly vegetation with shallow root systems (like grass) which stabilises the soil but does not cause large cycles of shrinkage and swelling or potential physical damage. PEG – There is a European group trying to standardise on embankments for earthworks, whose findings should be very beneficial for the problem of seasonal effects. GB – Geogrids and geotextiles are increasingly used to improve the slope stability, combined with pre-loading (e.g., on the Munich-Augsburg line).

## Work Area 2: Ballast and sleepers (Presentation by AZ)

- *Discrete element modelling (DEM).* PEG – Gilles Saussine at SNCF is doing similar and complementary research with DEM, and it would be good if cooperation could be increased. AMcN – Should this be done directly between universities, or could railway administrations promote the cooperation? WP – There is some benefit in railway administrations doing it because there is possibly a tendency amongst universities to focus too much on doing something that is considered world leading and new rather than contributing to a developing scientific opinion. Funders, too, are overly concerned about what they see as duplication of research, whereas the need is for a variety of people looking at the same problem. Even if they're using apparently similar ways—which will usually not be the case—they will actually each bring a slightly new perspective. At a recent conference, for example, there were 20 people from different universities all around the world all standing up and talking about “their model” for the behaviour of soil, and there was no meaningful dialogue or interaction between them at all. The reason for this is that they were all driven to be the first in a field of one rather than contributing to a body of knowledge that might do something socially useful. If rail administrations would provide the push, it would help to bring academic organizations together.
- *Under sleeper pads.* GB – I am surprised at the lack of focus on undersleeper pads; we have found there are all sorts of advantages to using them—from reduction of ballast settlement to improvements in noise and vibration. WP – We think they are part of the story and are looking at them as part of a whole system that is looking at prolonging ballast life by reducing attrition. The message that we very often get on undersleeper pads, though, varies from “we know all about it and you don't need to bother” to “we know they work, but we don't know how”. The interesting question is what we can do that is new and will add to what is already known. AMcN – I agree that a lot of research has been done and we do not want to replicate that research. We should be cognizant that most railway administrations now accept that USPs are part of the solution. If we do research on USPs as part of the project, we should focus on an interesting, new aspect. GB – Austria has now fixed its internal regulations and they now use USPs as standard; in Germany, we have a lot of experience and test sites, but to date, USPs are not the standard; they are only used in special circumstances (e.g., transition zones) because of lingering concerns over cost and sustainability/durability.
- *Random fibre reinforcement.* AMcN – With regard to the fibres being used in fibre reinforced ballast, can you tell us how long, how thick, and how much should be used? AZ/WP – The answer will come out of the experiments, and at this point we don't know what is optimal yet, but we should know within the next year. AMcN – If the objective is to get to a no-maintenance situation, then what is the benefit of a random mix over just creating a very structured and uniform solution in the first place (such as geo-grids or geo-textiles)? AZ – Although no maintenance is the aim, on occasion it could well prove necessary; in such cases, maintenance will be possible with fibre-reinforced ballast, but

difficult with structured solutions. WP – The random fibres should also be substantially cheaper than geo-grids or geo-textiles.

### **Work Area 3: Noise and vibration (Presentation by DJT)**

- AMcN – I'm concerned about the progress with vibration, and I would be very keen to know what you plan to achieve in the next 12 months and 24 months now that you actually have a team together. DT – the vibration work has focused in the first year on the stiffness of ballast as this links to the other work areas. There have been delays with the test rig but this is almost ready now. Predictions of critical speed effects could be done now (a proposal was made to HS2 for this) but could be done better in 1-2 years' time when the time domain modelling that is just starting has progressed. Other work on vibration mitigation is on-going in the RIVAS project.
- PEG – We see a growing importance of vibration now in addition to noise. There is no agreed or standard method of modelling vibration like the TWINS model that is available for noise. For track noise, we need more objective measurements of the track contribution and methods of reducing it as otherwise we will not be able to force the manufacturing industry of vehicles to make further progress. As you are proposing, we need global modelling of the track, complementary to the approaches you've already produced.
- AE – With regard to critical speed and vibration, there are studies by Anders Karlström, Torbjörn Ekevid, and others at Chalmers that can be used for benchmarking and validation.
- GB – What about the practical link? My impression is there is a strong scientific approach to the project, but mainly on the theoretical level. DT – we are also doing field measurements, e.g. of track decay rates and roughness.

Later note by WP: this work area is at a relatively early stage, and the comments regarding the need to integrate with other areas and into practice will guide our thinking for the work going forward.

### **Work Area 4: Field integration / Critical zone improvements (Presentation by JAP on behalf of CR)**

- AMcN – How does this fit in with the other three presentations? JAP – We're going to be monitoring the effectiveness of interventions informed by findings from work areas 1, 2, and 3.
- PEG – Do you think it is sufficient just to monitor and make measurements before and after remediation? To know whether the recommendations are right or not, wouldn't you need a global model to predict the behaviour that you expect? WP – I think you're absolutely right: development of the model is part of WA6 but it too needs to feed off the earlier work in WA's 1 through 3. Ideally, you would observe, you would use your model to explain the observed behaviour, you'd then use some predictions of future behaviour to plan the intervention, you'd do the intervention, you'd monitor after the intervention, and you would then use that to then calibrate or validate your model. And in addition to that, you would carry on monitoring after the intervention because the rate of deterioration is quite important. That is what we're aiming for but the modelling is at a very early stage.

### **Work Area 5: Laboratory integration / System integration (Presentation by GMcD)**

- AE – It could be interesting to apply a lateral load after the vertical load history to study, for example, the effect of fibre reinforcement on lateral stability. WP – We have the capability to do that in the Southampton rig.
- AMcN – What's the argument for duo-block sleepers? AZ – I think the argument was they've used them in France for a very long time, and they may be beneficial in preventing centre bending especially if you don't want to tamp the ballast.
- AMcN – There is a lot of novelty around the random reinforcements and that should be a priority. In my view, you should not waste too much time on the plastic, steel, and wood, but concentrate on concrete. GB – Plastic sleepers are beneficial because they reduce noise and vibration, for example on bridges, but they are very expensive. AMcN – in other words, they are a specialist application for a specialist problem.

- AMcN – With regard to the parametric study, I think it would be reasonable to have a control across the top – so, you have one type of ballast, but then be more selective coming down. It probably makes sense to concentrate on mono-bloc concrete sleepers; esoteric sleeper types should probably be considered secondary. We should also focus on ballast as an engineered material sitting on an engineered sub-base— that is at the heart of Track21. With regard to undersleeper pads, it makes sense to just choose one that is widely used and test that—this is not a parametric study on undersleeper pads.

There was general agreement with the last point, which effectively endorsed the proposed programme of testing starting with the “control” set of tests covering different sleeper types represented by the top row of the table presented. We are not at this stage proposing to investigate other sleeper types in any detail, and we are not going to carry out a study of different types of USP’s. The focus will be on standard concrete sleepers and different ballast types (eg with a changed grading or with random fibre reinforcements). The possibility of modelling the interaction between the ballast and the sub-base was also mooted.

#### **Work Area 6: Modelling integrations / Performance, environmental and economic modelling (Presentation by JMP)**

- AE – With regard to field applications, it would be good to distinguish between monitoring or output parameters and measured or input parameters.
- AE – We have projects dealing with optimisation of maintenance, and a question that always comes up is optimisation for whom? That is an important question. JMP – In terms of optimising for whom, we intend to do both a financial and a social analysis. The financial analysis would probably optimise for the infrastructure authority. The social analysis would optimise for the users and society.
- GB – Slabtrack gives a much higher ride quality, but the question is how do we put ride quality into a cost benefit analysis? It is difficult to reconcile experiments about what people prefer (stated preferences) with what they are prepared to pay for. JMP – I agree there are big dangers with using stated preference models; however, if you don’t use a value, you have to realize that you’re intrinsically saying that value is zero and it doesn’t matter. I think if you talk to most people, they will say that ride quality matters, so we need to find ways that we can incorporate that.
- PEG – We don’t need a single model; we need different models for different things, but we do need to think about how those models can feed into each other.

#### **Concluding Comments**

Members of the ISP all commented favourably on the way that the research programme is organised and the results that are emerging; and in particular on the linkage that is being achieved between sound scientific principles and understanding, and practical engineering applications.

There was broad agreement to the proposed programme of further work; and an agreement to try to forge more meaningful links for international collaborative research between key research providers and railway administrations in Europe and beyond.

Particular comments included:

- I was quite impressed with the results that are coming. The research is quite comprehensive and also quite structured; a scientific approach, but keeping it practical.
- A big challenge, being addressed in this project, is the link between the fundamentals and the practicalities.
- I think you’re doing a very good job, not only on the practical and the more fundamental, but also in the testing and the simulation and the understanding—this is complicated and complex, but you’re doing a good job.